Initial Insights into the LASSO[†]-CACTI[‡] Simulation Library for Deep Convective Clouds

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[†]LASSO: Large-Eddy Simulation (LES) Atmospheric Radiation Measurement (ARM) Symbiotic Simulation and Observation; [‡]CACTI: Cloud, Aerosol, and Complex Terrain Interactions

SUMMARY

➤ The LASSO activity makes available a new LES library to accompany the observational dataset for deep convection during the CACTI field campaign (see the Gustafson et al. poster for the LASSO overview).

➤ The library consists of the WRF-based mesoscale simulation ensembles, their skill scores compared to observations, and select large-eddy simulations (LES).

➤ This poster summarizes the simulation library and delves into initial impressions and characteristics of an example set of simulations for a 'case study' of convective clouds.

➤ The provided ensembles enable users to identify sensitivities of convection to environmental conditions for the simulated days.
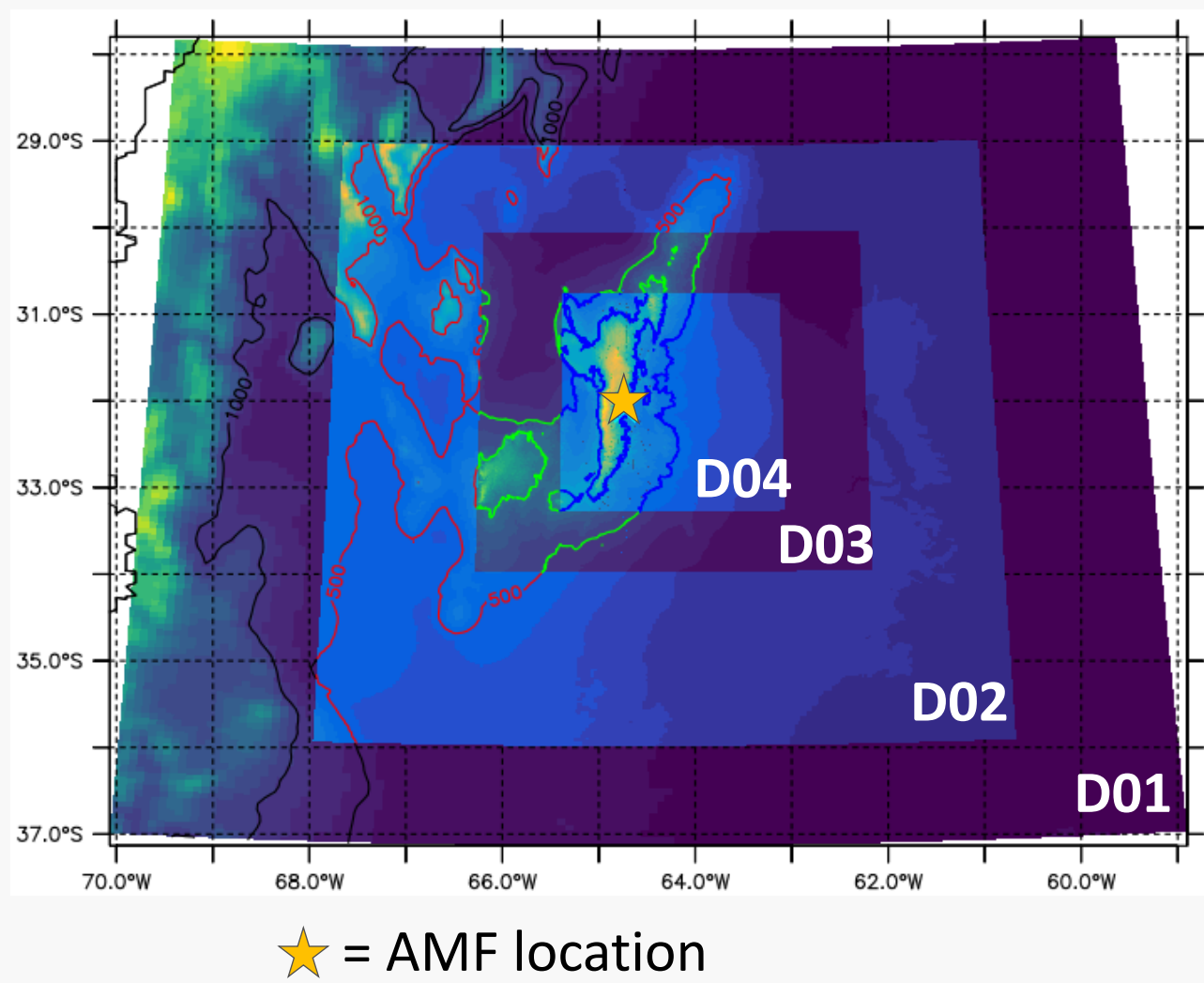
THE LASSO-CACTI SIMULATION LIBRARY

Select Cases

Twenty case days were selected for when convection occurred near the ARM Mobile Facility (AMF) for mesoscale simulations. Nine 'primary' cases were down-selected from the 20 based on well-behaved mesoscale ensemble members. for further simulations using LES. The other 11 cases are 'secondary.'
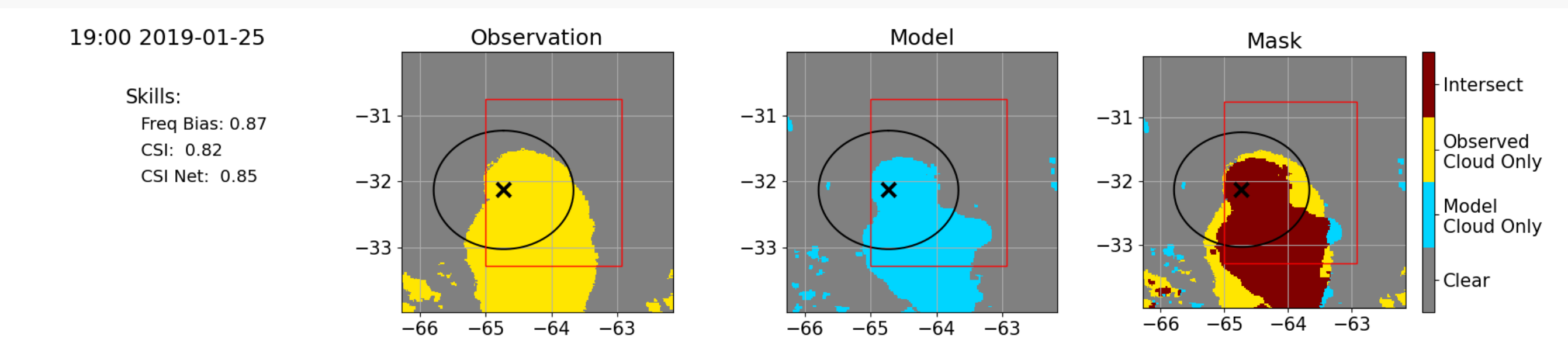
Simulations

All case days have mesoscale simulations with kilometer-scale grid spacing produced for up to 33 ensemble members using background fields from FNL, GEFS (21), ERA5, and ECMWF EDA (10). Based on skill scores, the best performing simulations are used for one or more LES simulations for the primary case days.

WRF domains were configured for 'mesoscale' simulations (D01-D02) using 7.5 and 2.5 km grid spacing and LES simulations (D03-D04) using 500 and 100 m grid spacing.

⭐ = AMF location

Skill Scores

Skill scores are provided to assess the time evolution of the convective area and intensity based on 1) GOES-16 infrared brightness temperature (Tb) cloud masks, 2) CSAPR2 echo-top heights, and 3) surface precipitation retrievals.

Cloud mask comparisons are given every 15 mins between observed GOES-16 (yellow) and mesoscale simulation (blue) masked for a brightness temperature threshold of 240 K. Overlapping masks shown in maroon. Red box approximately shows the LES domain; the black circle east of the red line indicates the radar visibility.

A CASE STUDY: JANUARY 25TH, 2019

On the day, convective clouds that initiated near the AMF site developed into a huge convective system. Mesoscale ensemble skill scores show a large spread.
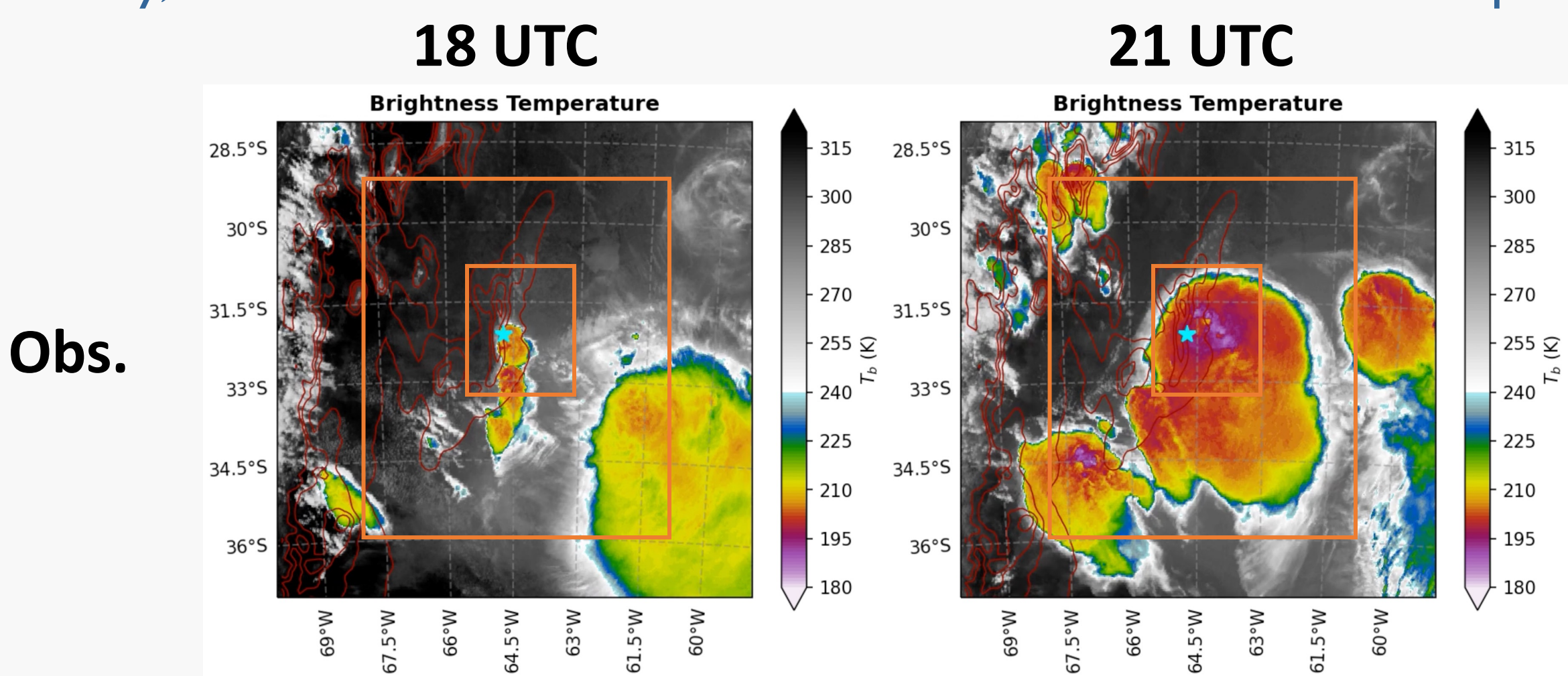

GOES-16 satellite brightness temperature at 18 and 21 UTC. AMF is indicated by light blue star. Red lines show selected terrain contours. Large and small orange boxes indicate D02 and D04 domains, respectively.

Time series of the Net CSI skill scores for Tb cloud mask for all ensemble members.
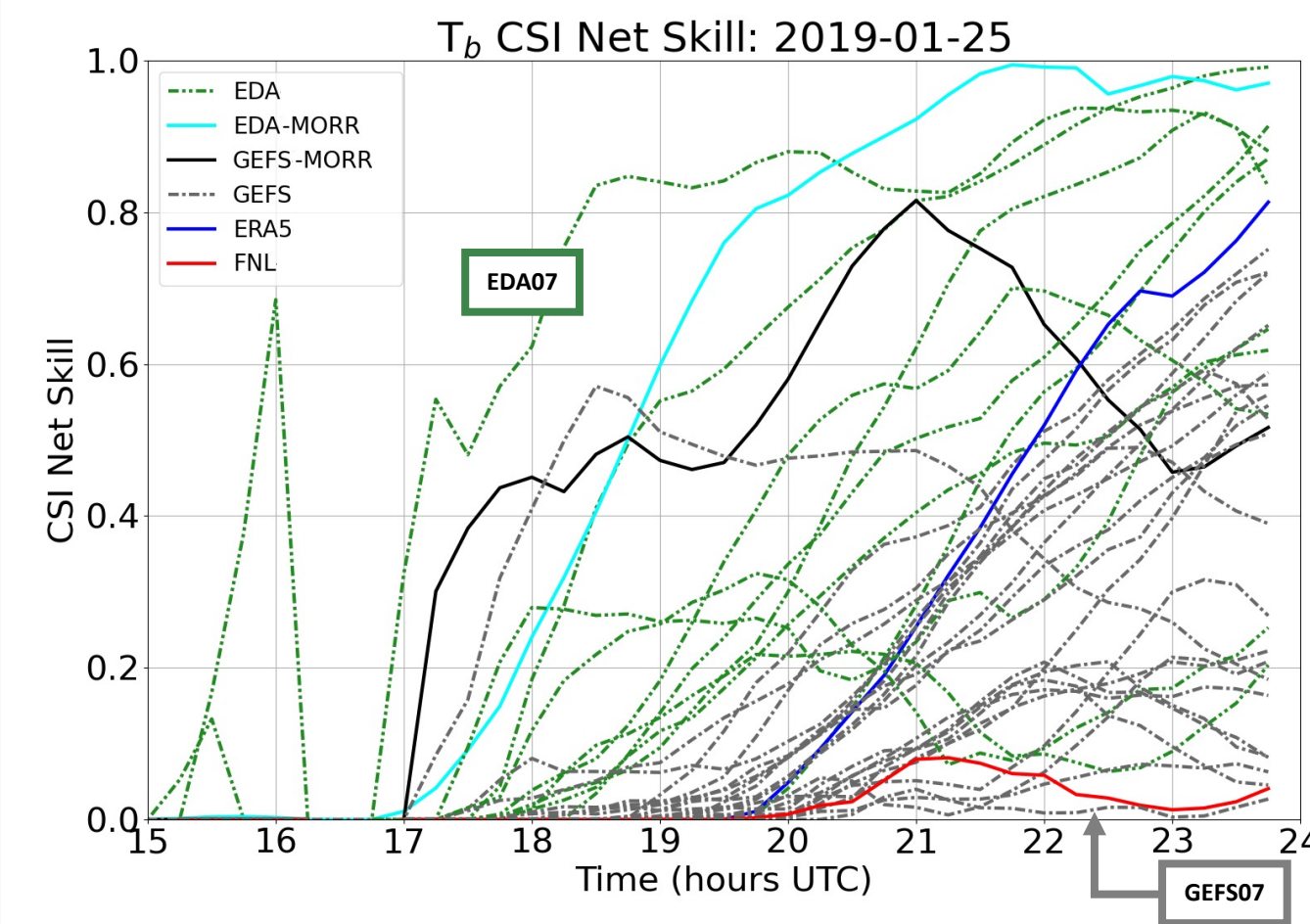
Good vs. Bad Mesoscale Simulations: Sensitivity to Forcing

The high-scored EDA07 simulation captures the cloud initiation and development. The GEFS07 simulation that failed to produce the convective clouds appears to have slightly less humid air at the lower levels.
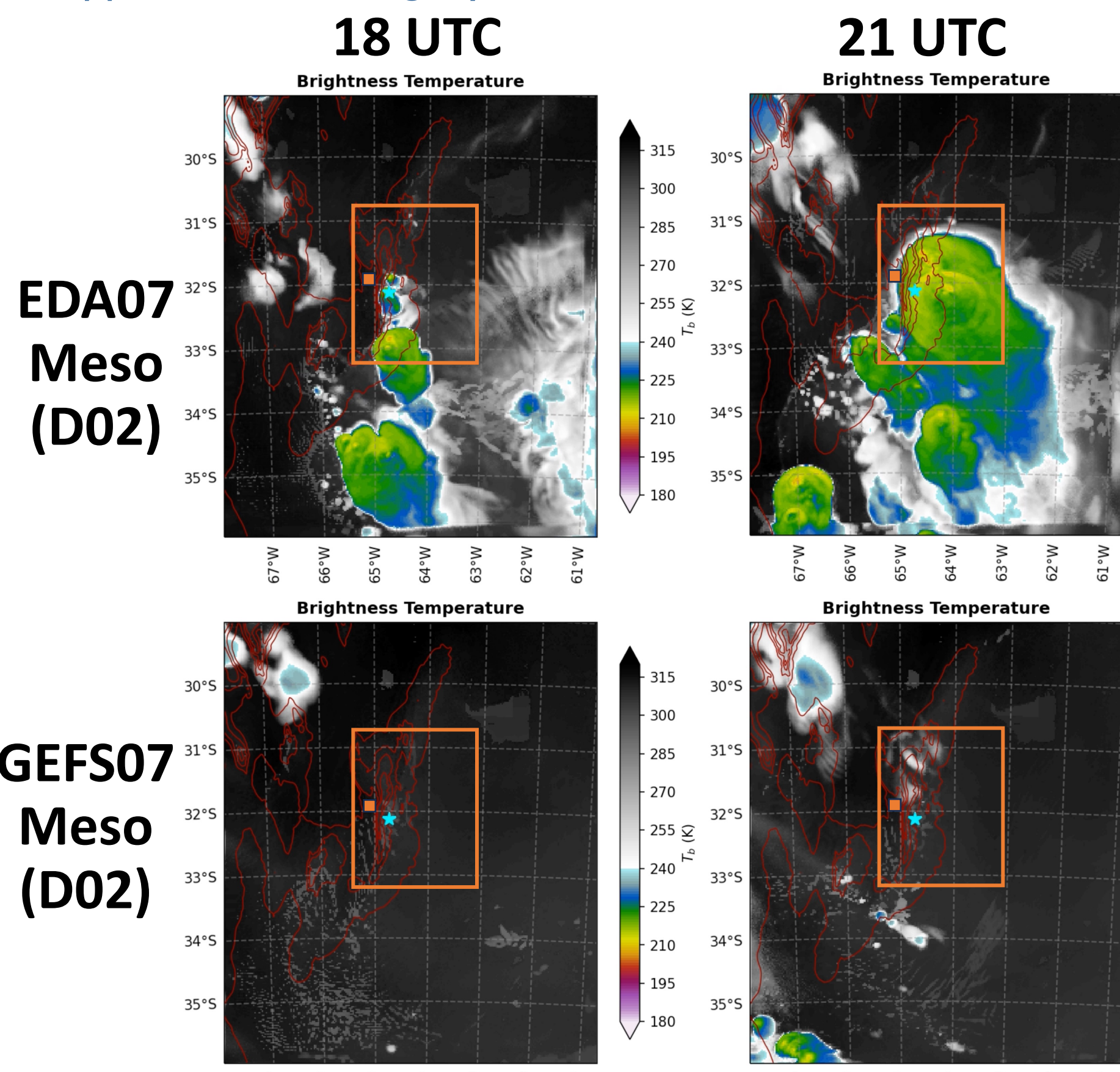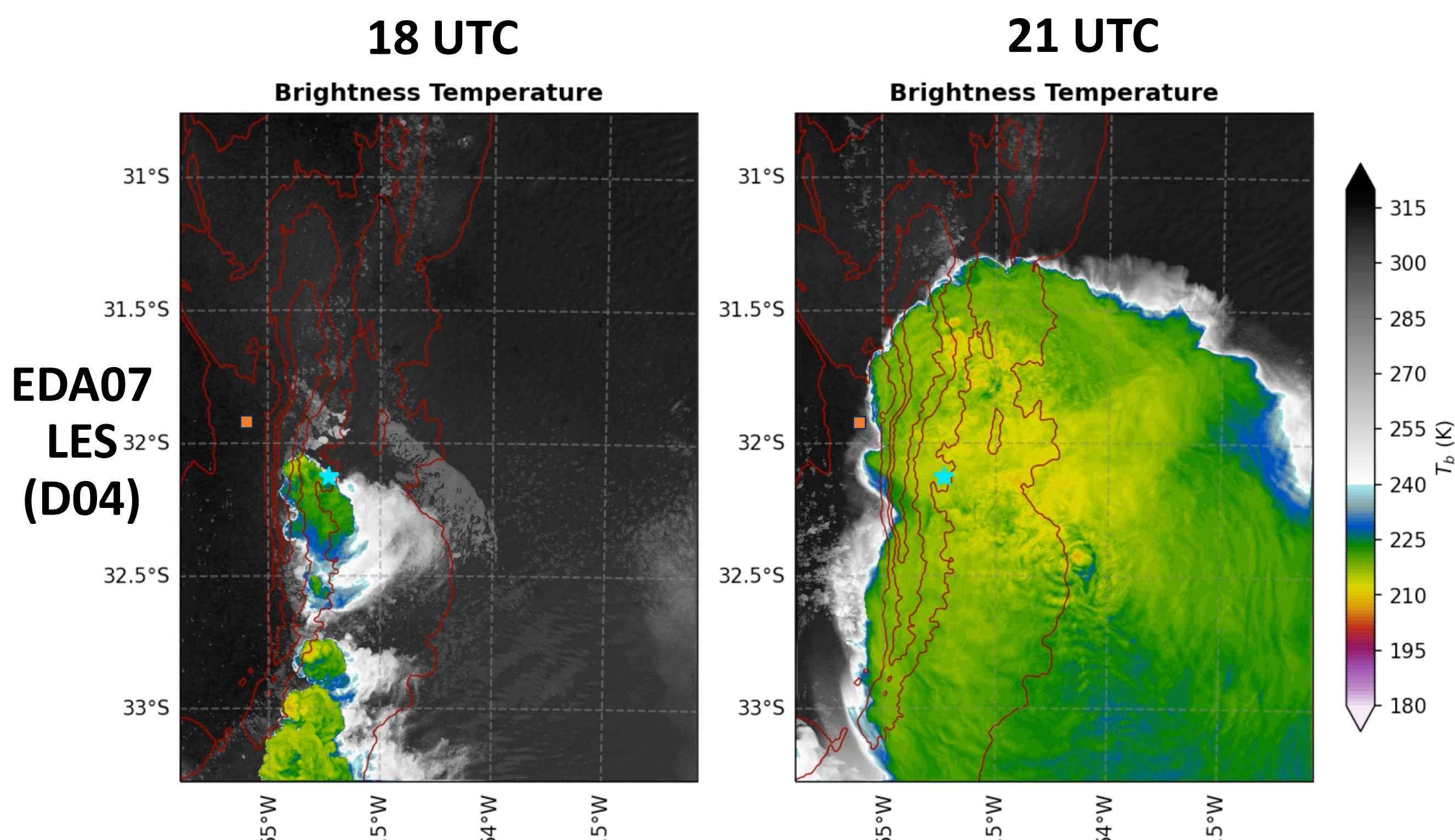

Brightness temperature at 18 and 21 UTC from D02 mesoscale simulations driven by EDA07 and GEFS07. Villa Dolores and AMF sounding sites are indicated by the light blue star and orange square. Red lines show selected terrain contours. Orange box indicates D04 domain.
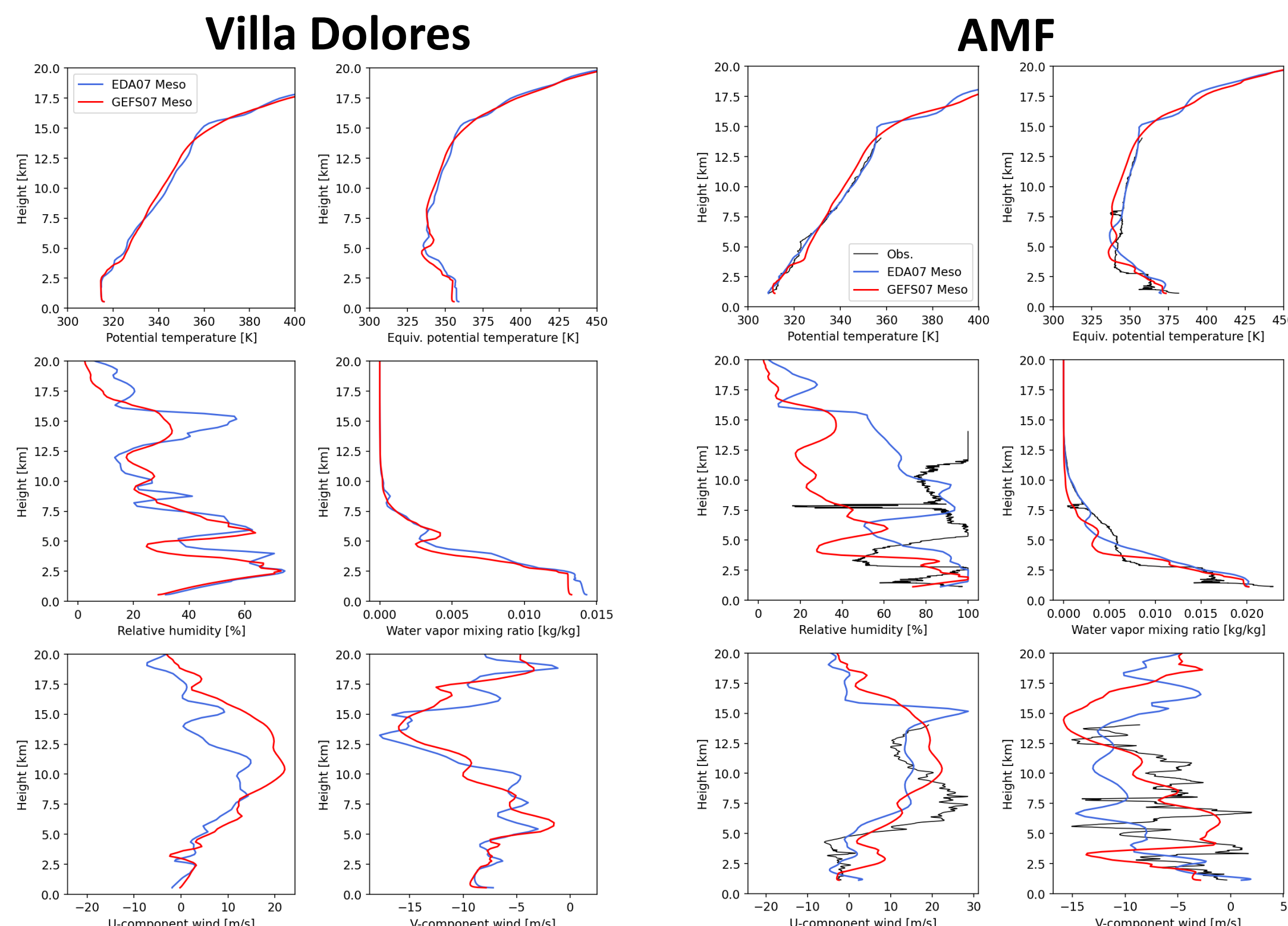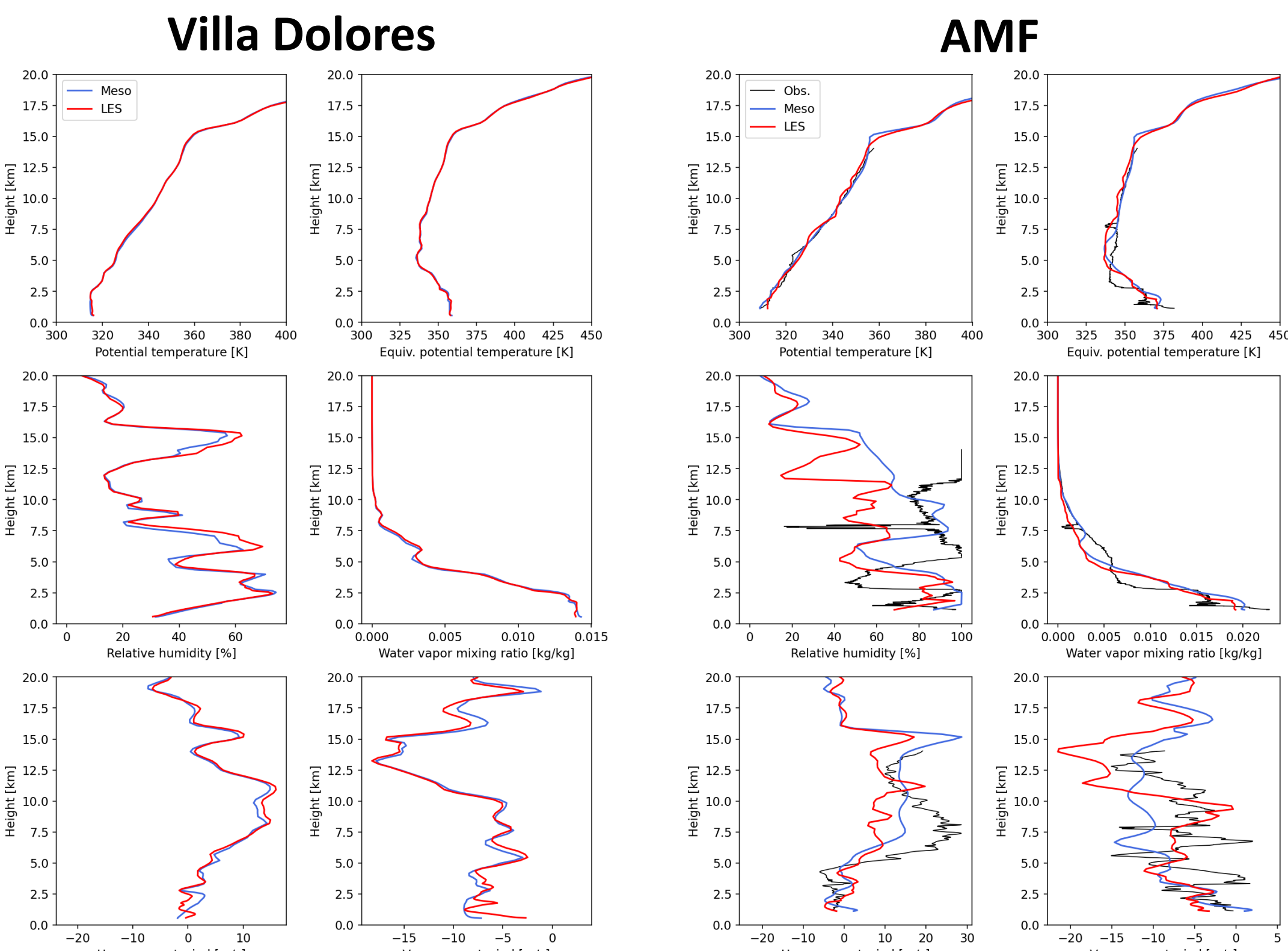

Vertical profiles at 18 UTC at Villa Dolores (left) and AMF (right) sounding sites in the D02 domain of mesoscale simulations driven by EDA07 (blue) and GEFS07 (red).

Mesoscale vs. LES Simulations: Sensitivity to Grid Spacing

LES simulations conducted for the well-performed EDA07 simulation provides the fine-scale convective system structures.

Brightness temperature at 18 and 21 UTC from D04 LES simulations driven by EDA07. Villa Dolores and AMF sounding sites are indicated by the light blue star and orange square. Red lines show selected terrain contours.

Vertical profiles at 18 UTC at Villa Dolores (left) and AMF (right) sounding sites in the D04 domain of LES simulations driven by EDA07.

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